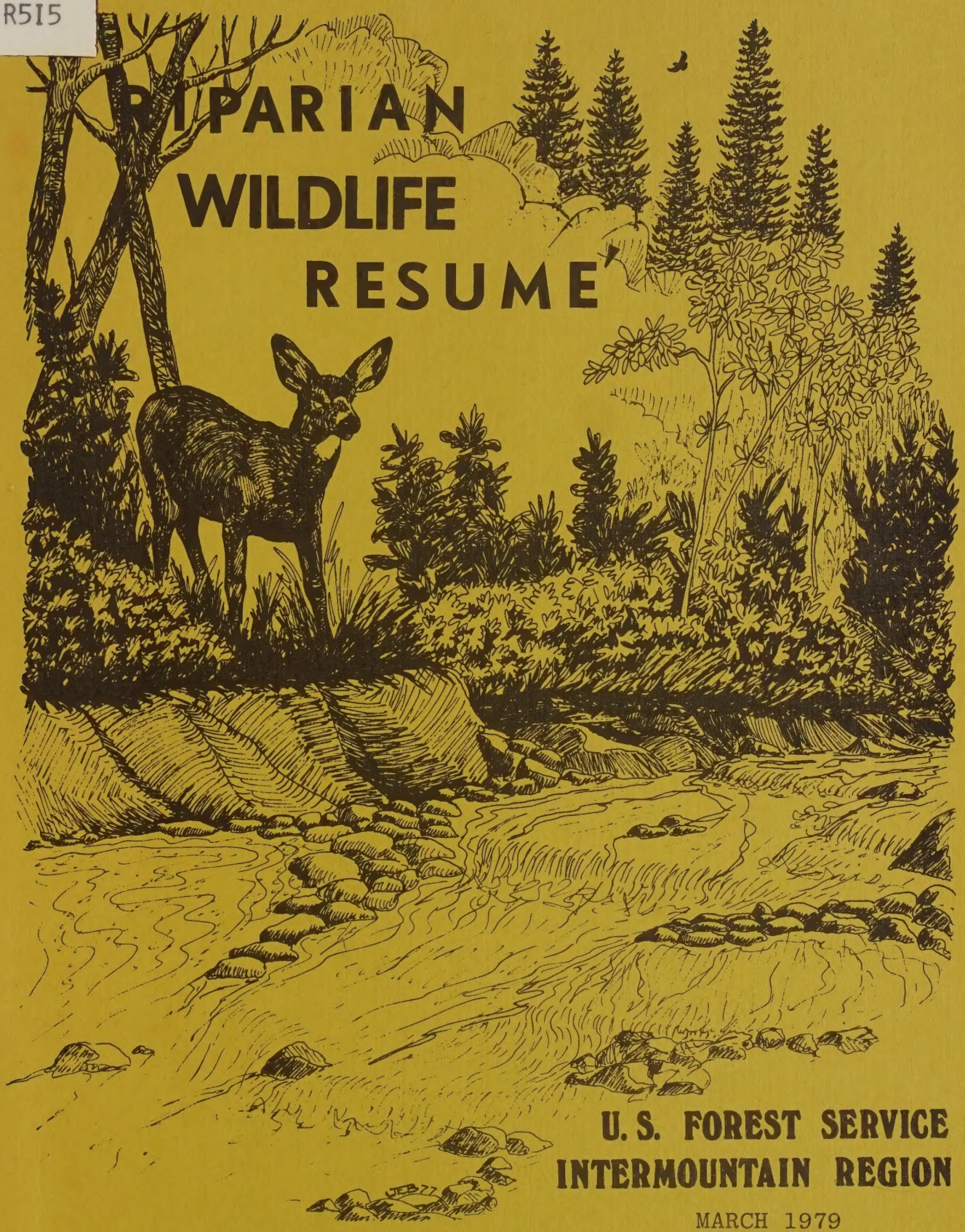
RIPARIAN WILDLIFE RESUME



U. S. FOREST SERVICE
INTERMOUNTAIN REGION

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THE IMPORTANCE OF RIPARIAN HABITATS AND THEIR MANAGEMENT TO WILDLIFE AND FISHERIES: A CURRENT RESUME OF KNOWLEDGE

USDA Forest Service
Intermountain Region
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INTRODUCTION

Riparian areas are recognized as one of the most productive and attractive of all wildlife habitats. The attention being given these habitats is increasing at a geometric rate. Numerous Regional and National workshops and symposiums have been held the past few years illustrating public concern for management within riparian habitats. This document highlights many of the significant findings concerning the importance of riparian areas for wildlife use. Two Executive Orders, 11990 (Protection of Wetlands) and 119988 (Floodplain Management), require that special attention be given to these areas. The position of the Forest Service is well represented in the following comments.

John R. McGuire (1978), Chief, USDA Forest Service stated the following: "... our basic policy on riparian management is sound. But we want to go beyond merely a reaffirmation of policy. We want to ensure that the letter, intent, and philosophy of this policy are evident wherever a riparian ecosystem exists on the National Forest System. The four main principles of the policy are:

1. "We will plan for and manage riparian ecosystems with full recognition of their importance and unique values.

2. "At the same time, we will manage riparian ecosystems as an integral component of the adjacent lands, under the principles of multiple use and sustained yield.

3. "We will protect and, where applicable, improve the riparian ecosystems--that is, the soil, water, and vegetation--as one of our basic stewardship responsibilities. This will be done prior to, or in conjunction with, other resource allocation decisions.

4. "We will also, as policy, continue research programs on the management, ecology, and protection of riparian environments for water, fish, wildlife, timber, livestock, and recreation values and uses.

"But, policy is one thing. Interpretation, and action on the ground, can be another. You know this, and I know it. So, let me explain how this policy will be--and I emphasize <u>will be</u>--integrated into National Forest land management planning. I'll start with the policy directions that will be issued shortly:

--"Riparian management will encompass the requirements of Executive Order 11990 for wetlands and Executive Order 11988 for floodplains, particularly the requirements to avoid, to the extent possible, adverse impacts from activities on the riparian ecosystem.

--"Public participation in all our planning and management--including that for riparian ecosystems is assured through the National Forest Management Act.

--"Land management plans will specifically state objectives for riparian ecosystems.

--"We expect to classify riparian ecosystems in the Forest Service National Land Classification System that we use in land management planning. Riparian ecosystems and associated lands will be inventoried and delineated as "Capability Areas" on the National Forest System.

--"Interdisciplinary teams will identify alternatives for protecting and managing riparian ecosystems as planning is done on each Forest or Grassland.

--"Our land managers will use environmental assessments to evaluate both the individual and cumulative effects of proposed actions in riparian ecosystems. This will ensure that the natural and beneficial values of these ecosystems are protected as the President has directed.

--"The actual on-the-ground effects of our actions within and adjacent to riparian ecosystems will be monitored and evaluated, keeping in mind the considerable expense associated with monitoring.

--"Riparian ecosystem planning and management on the National Forest System will be coordinated with other Federal agencies, the States, and local governments."

Concurrently, as stated in Wildlife Action (1978), it is the policy of Region 4 to give priority to maintaining special, unique, endangered and threatened wildlife habitats, such as streams and riparian zones.

Riparian communities have an importance to fish, wildlife, and outdoor recreation which is greatly disproportionate to the limited linear acreage of these areas (Brown et al. 1977). They are also the areas of maximum potential conflict between users of timber, grazing, recreation, water, and wildlife resources (Thomas et al. 1979). An inventory of Region 4 to specifically account for areas of riparian habitat has not been conducted. Data from range analysis does list 29,000 acres of wet meadows though other forms of riparian habitats along streams and lakes have been lumped with the adjacent vegetation type due to the inability to map areas less than 40 acres. At this time, the only figures of value in the estimation of acreage of riparian habitat are the miles of streams and acres of lakes and reservoirs listed in the Annual Wildlife Report (1972, Appendix A). Much work is needed regionwide in terms of inventory and analysis of riparian ecosystems. The valley bottom inventory program is the first step in this direction.

A CURRENT RESUME OF KNOWLEDGE

Riparian ecosystems are simply defined as those areas and biotic communities which are predominantly influenced by high water tables usually occurring adjacent to surface water. Because of the many possible sources of water, riparian ecosystems are as diversified as they are widespread. In the Intermountain West, riparian zones are represented by wet bogs, as well as associated with intermittent streams to perennial rivers, domestic water impoundments, natural lakes, and ponds. Despite the complexity and diversity inherent to riparian zones, certain homogeneous characteristics are identifiable. Thomas et al. (1977) described the common characteristics of all riparian zones in the Blue Mountains which are generally applicable to the Intermountain area: (1) they create well defined habitat zones within the much drier surrounding areas; (2) they make up a minor proportion of the overall area; (3) they are generally more productive per acre of biomass--plant and animal--than the remainder of the area; and (4) they are a critical source of diversity within the ecosystem.

Historically, man's survival and progress has been heavily dependent upon the bounties provided by riparian zones. Early settlers of the mountain west relied on rivers and streams not only for navigation, but also for the richness the riverine lands provided. The game and farm land was essential for successful colonization. However, it has been only in the past decade that researchers and managers have actively pursued ecological information pertinent to the sound management of riparian ecosystems. Only recently has the relationship between biotic diversity and the presence of riparian ecosystems been conscientiously recognized. Hubbard (1977) feels that the riparian zones of the southwest are of extreme importance in producing and maintaining a large degree of biotic diversity. Although this is most apparent in fishes and best quantified in birds, riparian ecosystems are critical for many plants and animals to flourish or even survive. The Council on Environmental Quality (1978) concurs that no ecosystem is more essential to the survival of the nations fish and wildlife resource.

The multiple use resource policy of the Forest Service challenges the land administrator to manage the resources within his jurisdication while assuring a sustained yield through the preservation and maintenance of the resource base. In the past, the lack of sufficient data relating to riparian zones has hampered the land manager in his decisions regarding these zones. This situation is particularly evident in areas where water is limited but public demand is high. In light of recent research and a growing public awareness of the value and the fragile nature of riparian zones, it is essential that these areas be managed for the diverse flora and fauna they provide. John McGuire (1978), Chief of the Forest Service, recently summed up the Forest Service attitude on riparian ecosystems in a statement to the National Riparian Ecosystems Symposium, "We want to find the best ways of managing resource use with riparian

areas...Forest Service policy and management are not fixed or static. They, too, continue to change and evolve, responding to both the resource and public sentiment. This is the only way in which we can truly recognize the values of the riparian ecosystem in both ecological and human terms."

IMPORTANCE TO WILDLIFE AND FISH

The value to wildlife of any vegetative community is directly proportional to the quality and quantity of habitat provided by that community. In most instances, riparian zones afford wildlife and aquatic life four basic habitat components: water, food, cover, and space essential to viable fauna populations. Within many other habitats, large quantities of these components are essentially unused, because they are spaced too far from other requirements for the animals involved (Dasmann, 1966). The interspersion or spatial relationship of food, water, and cover characteristic of riparian zones, contributes to the importance of riparian habitats to wildlife populations.

In ecological terms, a riparian zone is the interface, transition, or ecotone between a hydric (wet) and zeric (dry) community. The importance of the "edge effect" created by ecotones is widely recognized in wildlife management. Whenever two habitat types come together, the edge between the two types will generally be more favorable as wildlife habitat than either type considered alone. Ecotones have a larger number of species and total biomass than any comparable area contained wholly within one vegetative type (Dasmann 1966).

The key to understanding the wildlife values inherent to riparian zones is recognizing the importance of biotic diversity, as compared to simplicity. Diverse natural communities (i.e. riparian zones) are more stable than simple communities. However, stable communities are fragile to pressures and situations that do not naturally occur within their environment, such as man's disturbance. In addition, such communities are more productive in a gross, biological sense (Dasmann et al. 1973). Thomas et al. (1977) stated that the dramatic contrasts of the plant complex in a riparian zone to the general surrounding vegetation adds greatly to the diversity of the area. This diversity is enhanced by the irregular shape of many riparian zones which maximizes the production of edge.

The importance of riparian zones to the existence and productivity of anadromous and resident fishes is generally recognized. Streamside vegetation moderates water temperatures by limiting solar radiation, a critical factor during hot summer months when the potential for increased lethal water temperatures is most likely. During cold winter months, the same vegetation provides insulation against thermal loss. Primary production is regulated by solar filtering and temperature moderation through shading (Meehan et al. 1977). Riparian vegetation also supplies habitat for terrestrial insects as well as organic detritus for stream organisms. Filtering to limit sediment and debris from man's activities from entering the stream is an additional beneficial effect of streamside vegetation (Meehan et al. 1977).

Considering the importance of riparian vegetation to the fishery and the ecological well-being of aquatic communities, the Oregon-Washington Interagency Wildlife Committee (1979) formulated the following management recommendations:

1. Between 60 percent and 100 percent of the stream surface should be shaded from June to September during the hours of 10 a.m. and 4 p.m.

2. Streambanks should have 80 percent or more of their total linear distance in a stable condition.

3. No more than 15 percent of stream substrate should be covered by inorganic sediment because fine sediments contribute to pool inundation and clog spaces between gravel. This condition decreases water percolation and causes fish and insect mortality.

4. Riparian zones should provide at least 80 percent of the site enhancement potential for grass and forb cover.[1/]

5. Riparian zones should provide at least 80 percent of the site enhancement potential for shrub cover.

6. Riparian zones should provide at least 80 percent of the site enhancement potential crown cover for sites that would naturally be dominated by trees. For riparian zones that naturally contain only a few trees per acre (20 or less), optimum tree cover for wildlife is considered to be 100 percent of potential.

Recent research results have demonstrated that riparian habitats receive more use per unit area by wildlife than any other type (Carothers et al. 1974, Kelly et al. 1975). Thomas et al. (1977) reported that of the 379 terrestrial species known to occur in the Blue Mountains of Oregon, 280 are either directly dependent on riparian zones or utilize them proportionately more than any other type of habitat. They concluded that riparian zones are the single most important wildlife habitats in the Blue Mountains.

The most dramatic evidence for the dependence of wildlife species on riparian habitat has been produced recently by research related to bird populations. The highest avian population densities per unit area in North America were recorded for the Verde River and its tributaries in Arizona (Carothers and Johnson 1975). Preliminary evidence suggests that riparian zones are the single most important wildlife habitats in the southwest. In addition to breeding habitat, riparian zones are extremely important to migrating birds. Riparian zones have a higher density and diversity of migrating passerine birds than adjacent non-riparian habitats (Stevens et al. 1977). Stream and river corridors often serve as routes through inhospitable habitats (Wauer 1977).

Anderson et al. (1978) suggests that there is a significant straight line relationship between the number of avian species present and the horizontal foliage density of the area. In the same study, relatively large horizontal foliage densities appeared to be the single most important vegetative parameter relative to the attraction of a number of avian species. Further enhancement would occur with relatively large vertical height densities in combination with relatively large horizontal foliage densities (Anderson et al. 1978). Diversity is also determined by the aggregation, condition, and amount of various habitat types comprising a given riparian zone (Ed Schlatterer, personal communication).

[1/] Site enhancement potential is a subjective estimate of the potential vegetative production, natural or introduced, as determined by the Oregon-Washington Interagency Wildlife Committee.

A wide variety of mammalian species are associated with, and/or dependent upon, riparian habitats. Typical species that depend on riparian zones to complete their life cycle, are beaver (Castor canadensis), river otter (Lutra canadensis), and muskrat (Ondatra zibethica). Other species utilize riparian areas in association with other habitat types, but can survive without riparian systems. Although these species are not dependent upon riparian habitats for survival, populations of species like elk (Cervus canadensis) and racoon (Procyon lotor) would undoubtedly be adversely affected in the absence of these zones. Other species, such as moose (Alces alces) utilize a variety of habitats during the year, but may require riparian zones on a seasonal basis though Houston (1976) found willow types received the greatest use during all seasons.

In many situations, it is difficult to evaluate the real importance of riparian habitats to specific animal species. Often, a species will display varying degrees of dependency upon riparian habitats according to geographic area, season, and availability. For example, during the summer, elk in the Blue Mountains in Oregon spend 40 percent of their time in riparian zones that make up only 7 percent of the area (Thomas et al. 1977). In the Wichita Mountains of Oklahoma, where water is limited in the summer, July studies showed cow and calf elk utilization

of wooded bottomlands to be 30 and 48 percent respectively (Waldrup and Shaw 1978). Craighead et al. (1973) noted the importance of snow-free thermal areas along streams in Yellowstone National Park to the winter survival of the resident elk herds. On both eastern and western Montana elk ranges, Lyon (1975) identified moist sites in specific habitat types as important components of elk summer range. Lyon further confirmed the importance of wet areas by measurement of physical characteristics of 124 elk bedding sites, 75 percent of which were located in wet conditions. The literature suggests that riparian areas are an integral part of preferred elk range where interspersed with other habitat components and may be the single most important habitat factor contributing to the survival and perpetuation of healthy elk herds.

RESOURCE IMPACTS IN RIPARIAN HABITATS

Road Construction

The productivity, accessibility, and aesthetic values of riparian zones contributes to the importance of these areas to other forest and range uses. Because of natural beauty and topography, riparian zones are often ideal for road construction and recreational development. Streamside areas are generally productive timber sites and offer excellent livestock grazing. Unfortunately, the retention of wildlife and fishery values and the development and utilization of riparian zones are not always compatible. Riparian zones are very sensitive to habitat manipulation and must be considered delicate due to the combination of restricted area, distinct microclimate, vegetative structure and composition, and water quality and quantity (Thomas et al. 1977).

Logging

In recent years, the Forest Service has made great efforts to understand and minimize the impacts of timber harvesting on or adjacent to riparian zones. Research on the effects of clearcutting and slash burning on Northern Idaho stream quality revealed significant increases in pH, electrical conductivity, turbidity, suspended solids, bicarbonate, sulfate, potassium, calcium, and magnesium (Snyder et al. 1975). The potential for negative impacts such as decreased productivity and spawning success on stream environment as a result of these additives is great. Likewise, the reduction of the streamside forest canopy contributes to the detrimental effect on the resident organisms by altering stream temperatures through increased solar radiation. Significant increases in water temperature following logging has been reported in Oregon (Brown and Krygier 1976) and on salmon streams in Alaska (Meehan et al. 1969). Pierce et al. (1970) reported temperature increases up to 6^{o}C following forest clearing in New Hampshire. In riparian zones, single tree or group selection harvest methods will have less impact than clearcutting, seed tree or shelterwood cuts. Buffer strips are effective in lessening the impact of timber harvesting and should be used in riparian zones. In areas of scoured channel bottoms, logging may be beneficial to the aquatic environments if debris deposition is not excessive. Debris in streams create habitat for aquatic organisms by serving directly as a substrate by decreasing velocity and modifying streamflow to form depositional areas (Swanson and Lienkaemper 1978).

In timber harvesting operations where excessive sedimentation and temperature increases can be eliminated, the potential exists for increasing the productivity of headwater streams and improving existing fisheries by manipulating vegetation (Sharpe 1975). Sharpe (1975) suggested the following benefits could be derived from timber harvest systems on upland streams:

1. Increased streamflow during months of lowest flow will create more habitat for aquatic flora and fauna. This may sufficiently relieve the

stresses on the ecosystem attendant to a critical low water situation, thus resulting in greater production of aquatic insect species.

2. The increased sunlight on the stream channel resulting from selective timber harvesting in the riparian zone could stimulate greater primary production benefiting the entire food chain. In addition, the forest openings created along streambanks would encourage the production of terrestrial insects, important constituents of trout diets during the summer months when numbers of aquatic invertebrates are at their lowest.

3. Nutrient outflows following clearcutting would likewise serve to enrich upland streams to the advantage of trout populations; however, if not regulated, such nutrient increases could lead to eutrophication.

Recreational Use

Recreational development in riparian zones will enhance human-wildlife contacts, but will decrease effectiveness of the riparian zone for wildlife due to disturbance and habitat degradation (Thomas et al. 1977). Aitchison (1977) reported that the construction of a selected campsite in the southwest caused a shift in the natural species composition of avifauna in the surrounding riparian habitats. Once the campground was opened for human use, the breeding bird population decreased in density and diversity. He offered the following recommendations:

1. Locations for new campgrounds should be carefully evaluated in terms of usage by wildlife.

2. Existing campgrounds should be periodically closed to allow regeneration of vegetation and reduce stress on resident wildlife.

3. Opening the campground before or after the height of the breeding season may benefit the avifauna.

4. Habitat manipulation degradation should be carefully controlled (i.e. noise, firewood cutting, trenching for tents, and clearing of snags, brush, and slash).

5. Educational programs may be the only effective solution to human recreation and wildlife problems.

Grazing

Probably no other resource use of riparian zones has received more criticism than livestock grazing. Thousands of miles of riparian habitats have been and are affected by livestock grazing on public and private lands. The presence of water and succulent vegetation in riparian areas encourages livestock to frequent these areas. In addition, riparian zones provide: (1) relief if the surrounding terrain is rugged, (2) shade in hot climates, and (3) windbreaks in cold climates. Improper livestock grazing of riparian zones in 11 western states has been identified as the major cause in reducing the productivity of fish and wildlife habitats as well as degrading water quality and influencing flow fluctuations (Oregon/Washington Interagency Wildlife Committee 1979). Grazing impacts can be detrimental to wildlife, fisheries, and water quality through soil compaction and sedimentation, loss of bank stability, and loss of riparian vegetation including shrub species.

The scientific literature contains many reports denoting the impacts grazing has had on aquatic and riparian resources in the west. In Oregon, overgrazing has long been recognized as a major contributor to the loss of trout and salmon habitats (Bakke 1977). In Big Creek, Utah, trout populations were found to be 360 percent higher in ungrazed stream reaches than in grazed stream reaches (Duff in press). Gallizioli (1977) reported that in Arizona, overgrazing by livestock is the most important range management problem limiting the attainment of potential fish and wildlife benefits. Platts (1978) doubted that present grazing

strategies are capable of solving the problems in the riparian and aquatic environment caused by grazing. His recommendation was that researchers enter into an interdisciplinary effort to formulate alternative grazing strategies which will produce plans affording maximum consideration and understanding of the aquatic and riparian resources.

Cooper (1978) reported a significant correlation between bank-channel stability and livestock damage. He also noted that because of the attractive nature of riparian zones to livestock, sensitive streambanks cannot be protected just by reducing livestock numbers. To dramatize the situation, Ames (1977) stated that on the Coronado National Forest, there is no known system of livestock management that will give adequate

protection to riparian zones. Even short term use or seasonal use is inadequate. His solution to ensuring adequate protection of riparian types is by fencing them from livestock use except for selected watering places. Kimbal and Savage (1977) reported that the implementation of a rest/rotation system in conjunction with willow plantings on a severely grazed cattle allotment in Utah, produced a positive response in the ecosystem. Numbers of sculpin and cutthroat increased in direct proportion to the decrease in cattle use as did herbage production. They suggested that the continuation of this grazing system would maintain an upward trend in the riparian and aquatic zones.

RESEARCH NEEDS AND MANAGEMENT EMPHASIS

Riparian zones need increased research and management emphasis at a level comparable to its importance for wildlife and fish. Patton (1977) suggested six categories of study that are necessary to provide natural resource managers with sound data for making decisions: (1) influence of man on nature, (2) plant-animal associations, (3) vegetation classification, (4) inventories and maps, (5) silvics of tree species, and (6) life histories of vertebrate species. Problems pertaining specifically to wildlife fish, and the riparian resource which need to be solved, include:

1. The minimum area and suitable configurations necessary to retain both plant and wildlife values in different riparian habitats (Johnson et al. 1977).

2. The maximum distance which can separate islands of given habitat type before loss of wildlife species or a great reduction in populations occurs (Johnson et al. 1977).

3. Optimal as well as minimal requirements for enhancing wildlife values for a given habitat type (Johnson et al. 1977).

4. Develop methodologies that will detect, within narrow confidence intervals, the natural variation in streamside vegetation, streambank and stream channel conditions, fish standing crops, and community structure (Platts 1978).

5. Modify current resource use strategies, specifically grazing, or develop new strategies that will have environmental compatibility (Platts, 1978).

The most urgent need is undoubtedly the creation of an awareness in all land managers for the importance and fragile nature of riparian zones. Particular care should be taken to ensure that wildlife and fish values are accurately evaluated in land use plans involving these important habitats. Interdisciplinary teams, including aquatic and terrestrial habitat biologists, should be consulted whenever riparian zones are subject to proposed manipulation or utilization. Riparian ecosystems may well be the most important wildlife and fish habitat in North America and should be managed accordingly.

Additional references are included for your information (Appendix B).[1]

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[1]Riparian Habitat Subcommittee of the Oregon/Washington Interagency Wildlife Committee, 1979. Managing riparian ecosystems (zones) for fish and wildlife in eastern Oregon and eastern Washington. Region 6, 44 pp.

LITERATURE CITED

Aitchison, S. W. 1977. Some effects of a campground on breeding birds in Arizona. pp. 175-182. In Proc. Symp. on Importance, Preservation, and Management of Riparian Habitat. USDA For. Serv. Gen. Tech. Rep. RM-43, 217 pp.

Ames, C. R. 1977. Wildlife conflicts in riparian management. pp. 175-182. In Proc. Symp. on Importance, Preservation, and Management of Riparian Habitat. USDA For. Serv., Gen. Tech. Rep. RM-43, 217 pp.

Anderson, Bertin W., Robert D. Ohmart, and John Disano. 1978. Revegetating the riparian floodplain for wildlife, pp. 318-331. In Proc. Symp., Strategies for Protection and Management of Floodplain Wetlands and Other Riparian Ecosystems. Callaway Gardens, Ga., USDA For. Serv. GTR-WO-12, Dec. 11-13, 1978, 410 pp.

Bakke, B. M. 1977. Grazing is destroying our fish. Action Line July: 7-9 Trout Unlimited, Portland, Ore.

Brown, D. E., H. L. Lowe, and J. F. Hausler. 1977. Southwestern riparian communities: their biotic importance and management in Arizona, pp. 201-211. In Proc. Symp. on Importance, Preservation, and Management of Riparian Habitat. USDA For. Serv. Gen. Tech. Rep. RM-43. 217 pp.

Brown, G. W., and J. T. Krygier, 1967. Changing water temperatures in small mountain streams. J. Soil and Water Conserv. 22(6):242-244.

Carothers, S. W., R. R. Johnson, and S. W. Aitchison. 1974. Population structure and social organization of southwestern riparian birds. Amer. Zool. 14:97-108.

Carothers, S. W. and R. R. Johnson. 1975. Water management practices and their effects on nongame birds in range habitats. pp. 210-222. In Proc. Symp. on Management of Forest and Range Habitats for Nongame Birds, D. R. Smith, Tech. Coord. USDA For. Serv. Gen. Tech. Rep. WO-1, 343 pp.

Cooper, J. L. 1978. A technique for evaluating and predicting the impact of grazing on stream channels. Trans. Bonneville Chap. Amer. Fisheries Soc., Salt Lake City, Utah, Feb. 3-4, 1978.

Council on Environmental Quality. 1978. The ninth annual report of the council on environmental quality. 599 pp.

Craighead, J. J., F. C. Craighead, R. L. Ruff, and R. O. O'Gara. 1973. Home ranges and activity patterns of non-migratory elk of the Madison Drainage Herd as determined by biotelemetry. Wildl. Monogr. 32. 50 pp.

Dasmann, R. F. 1966. Wildlife Biology. John Wiley and Sons, Inc. N.Y. 231 pp.

_____, J. P. Milton, and P. H. Freeman. 1973. Ecological Principles for Economic Development. Garden City Press, Great Britain. 252 pp.

Duff, Don A. (In Press). Livestock grazing impacts on aquatic habitat in Big Creek, Utah. In Symp. on Livestock Interactions with Wildlife Fisheries and Their Environment (John Mehnke, Ed.) Sparks, Nv., May 1977. USDA For. Serv., Pacific S.W., For. and Rng. Exp. Stn., Berkeley, CA.

Forest Service. 1972. Annual Wildlife Report. Intermountain Region, Ogden, Utah.

Forest Service. 1978. Wildlife Action. Intermountain Region, Ogden, Utah. 25 pp.

Gallizioli, S. 1977. Statement at a seminar on improving fish and wWildlife benefits in range management. U.S. Fish Wildl. Serv. Biol. Serv. Program FWS/OBS-77/1. pp. 90-96.

Houston, Douglas B. 1968. The Shiras moose in Jackson Hole, Wyoming. Technical Bulletin No. 1. Grand Teton Natural History Association. 110 pp.

Hubbard, John P. 1977. Importance of riparian ecosystems: biotic considerations. pp. 14-18. In: Proc. Symp. on Importance, Preservation, and Management of Riparian Habitat. USDA For. Serv., Gen. Tech. Rep. RM-43, 217 pp.

Johnson, R. R., L. T. Haight, and J. M. Simpson. 1977. Endangered species vs endangered habitats: A Concept. pp. 68-79. In Proc. Symp. on Importance, Preservation, and Management of Riparian Habitat. USDA For. Serv. Gen. Tech. Rep. RM-43. 217 pp.

Kelly, W., R. Hubbell, S. Loe, and L. Shikany. 1975. Management of Riparian Habitats. USDA For. Serv. Coord. Guides for Wildl. Hab. No. 9, 9 pp.

Kimbal, J. and F. Savage, 1977. Diamond Fork aquatic and range habitat improvement. USDA For. Serv. Intermountain Region. 19 pp.

Lyon, J. L. 1975. Coordinating forestry and elk management in Montana: initial recommendations. Trans. N. Amer. Wildl. Nat. Res. Conf. 40:193-201.

McGuire, J. R. 1978. A riparian policy for changing times. In Proc. Symp. on Strategies for Protection and Management of Floodplain Wetlands and Other Riparian Ecosystems. Callaway Gardens, Ga. Dec. 11-13, 1978. USDA, For. Serv. GTR-WO-12. 410 pp.

Meehan, W. R., W. A. Farr, D. M. Bishop and J. H. Patric, 1969. Some

effects of clearcutting on salmon habitat of two southeast Alaska streams. Pac. N. W. For. and Range Exp. Sta. USDA For. Serv. Res. Pap. PNW-82.

Meehan, W. R., F. J. Swanson, and J. R. Sedell. 1977. Influences of riparian vegetation on aquatic ecosystems with particular reference to salmonid fishes and their food supply. pp. 137-145. In Proc. Symp. on Importance, Preservation, and Management of Riparian Habitat. USDA For. Serv. Gen. Tech. Rep. RM-43, 217 pp.

Oregon/Washington Interagency Wildlife Committee. 1979. Managing riparian ecosystems (zones) for fish and wildlife in eastern Oregon and eastern Washington. Prepared by Riparian Habitat Subcommittee. 29 pp.

Patton, D. R. 1977. Riparian research needs. pp. 80-82. In Proc. Symp. on Importance, Preservation, and Management of Riparian Habitat. USDA For Serv., Gen. Tech. Rep. RM-43, 217 pp.

Pierce, R. S., J. W. Ornbeck, G. E. Likens, and F. H. Bormann, 1970. SASHUNESCO, Symposium on the results of research on representative and experimental basins, Wellington, New Zealand. pp. 312-238.

Platts, W. S., 1978. Livestock interactions with fish and aquatic environments: problems in evaluation. Trans. 43rd N. Amer. Wildl. and Nat. Res. Conf. 43:498-504.

Sharpe, W. E. 1975. Timber management influences on aquatic ecosystems and recommendations for future research. Water Res. Bull. 11(3):546-550.

Snyder, G. G., W. F. Haupt, and G. H. Belt, Jr. 1975. Clearcutting and burning slash alter quality of stream water in northern Idaho. USDA For. Serv. Res. Pap. INT-168, 34 pp. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Stevens, L., B. T. Brown, J. M. Simpson, and R. R. Johnson. 1977. The importance of riparian habitat to migrating birds. p. 156-164. In Proc. Symp. on Importance, Preservation, and Management of Riparian Habitat. USDA For. Serv., Gen. Tech. Rep. RM-43, 217 pp.

Swanson, Frederik, J. and George W. Lienkaemper. 1978. Physical consequences of large organic debris in Pacific Northwest streams. Gen. Tech. Rep. PNW-69. 12 pp.

Thomas, J. W., C. Maser, and J. E. Rodick. 1977. Riparian zones--their importance to wildlife and their management. Reno Wildlife Workshop. April 1977.

_____ 1979. Riparian zones in managed rangelands-their importance to wildlife. pp. 21-31. In Forum-Grazing and Riparian/Stream Ecosystems at Denver, Co. Trout Unlimited, Inc. 94 pp.

Waldrip, G. P. and J. H. Shaw. 1978. Movements and habitat use by cow and calf elk at the Wichita Mountains National Wildlife Refuge. In Press. In Proc. Symp. on Elk Management. Laramie, Wyo., April 1978.

Wauer, Roland H. 1977. Significance of Rio Grande riparian systems upon the avifauna. pp. 165-174. In Proc. Symp. on Importance, Preservation, and Management of Riparian Habitat. USDA For. Serv., Gen. Tech. Rep. RM-43, 217 pp.

APPENDIX A

Running and Standing Water Statistics

Region 4	Miles of Streams	No. of Lakes	Acres of Lakes	No. of Reservoirs	Acres of Reservoirs
California	378	99	2,456	12	265
Colorado	5	-		1	100
Idaho	6,408	1,297	13,939	37	44,491
Nevada	951	30	50,191	7	114
Utah	2,754	708	14,211	253	26,550
Wyoming	2,278	968	31,694	19	32,339

Taken from data compiled in 1972.

APPENDIX B

REFERENCES

Alderfer, R. B., and R. R. Robinson. 1974. Runoff from pastures in relation to grazing intensity and soil compaction. J. Am. Soc. Agron. 39:948-958.

Ames, Charles R. 1977. Wildlife conflicts in riparian management: grazing. In Importance, preservation and management of riparian habitat. Symposium, USFS Gen. Tech. Report RM-43, Tucson, Arizona, July 9, 1977.

Armour, Carl L. Effects of deteriorated range streams on trout. Bureau of Land Management, Idaho State Office. 7 pp.

Arnold, J. F. 1955. Plant life-form classification and its use in evaluating range conditions and trends. J. Range Mgt. 8(4):176-181.

Arnold, Jameson and Reid. 1964. The pinion-juniper type of Arizona: effects of grazing, fire and tree control. USDA, Production Research Report #84, USFS.

Bakke, B. M. 1977. Grazing is destroying our fish. Action Line - Trout Unlimited, Portland, Oregon, July 1977. Pages 7-9.

Behnke, Robert J. 1977. Livestock grazing impacts on stream fisheries: problems and suggested solutions. In John Mehnke, ed. A symposium on livestock interactions with wildlife, fisheries and their environments. Sparks, Nevada, May 1977. USDA For. Serv., Pacific Southwest For. and Range Exp. Stn., Berkeley, California.

Berry, Charles R. 1978. Impact of sagebrush management on riparian and stream habitat. Utah Cooperative Fishery Research Unit. Logan, Utah.

Berry, C., and P. Goebel. 1978. The use of exclosures in fishery management. Utah Acad. Sci. Arts and Letters. Spring meeting, Utah State Univ., Logan. Abstr. Encyclia Vol. 55. (In press.)

Blaisdell, James P., Vinson L. Duvall, Robert W. Harris, R. Duane Lloyd, and Elbert H. Reid. 1970. Range research to meet new challenges and goals. J. Range Mgt. 23(4):227-234.

Blydenstein, J., C. R. Hungerford, G. I. Day, and R. R. Humphrey. 1957. Effect of domestic livestock exclusion on vegetation in the Sonoran Desert. Ecology 38:522-526.

Borovicka, Robert, and Ralph Culbertson. 1975. Birch Creek aquatic habitat management plan. Bureau of Land Management, Idaho Falls District.

Boussu, M. F. 1954. Relationship between trout populations and cover on a small stream. J. Wldf. Mgt. 18(2):229-239.

Branson, Farrel A., Gerald F. Gifford, and J. Robert Owen. 1972. Rangeland hydrology. Soc. Range Manage., Range Sci. Ser. 1, Denver, Colorado. 84 pp.

Bureau of Land Management. 1974. Livestock grazing management on national resource land. Final environmental impact statement. U.S. Bur. Land Manage., Washington, D.C. 2 Suppl., Various pagination.

Butler, R. L. 1968. The reactions of dominant trout to changes in overhead artificial cover. Trans. Am. Fish. Soc. 97(1): 37-41.

Claire, E., and R. Storch. 1978. Streamside management and livestock grazing: an objective look at the situation. Symposium on livestock interactions with wildlife, fish and their environments. U.S. Dep. Agric. For. Serv., Berkley, Calif. (In press.)

Claire, Errol W. 1977. Fish population and habitat studies on Camp Creek. Unpublished report, Oregon Department of Fish and Wildlife.

Cook. 1977. Effects of season and intensity of use on desert vegetation. Utah Ag. Exp. Sta., Utah State Univ., Bull. #483.

Cooper, James L. 1978. A technique for evaluating and predicting the impact of grazing on stream channels. Trans. Bonneville Chapter AFS, Salt Lake City, Utah, Feb. 3-4, 1978.

Cordone, A. J., and D. W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. California Department of Fish and Game 47(2):189-228.

Council for Agricultural Science and Technology. 1976. A review of the U.S. Dept. of Interior-Bureau of Land Management draft environmental impact statement--proposed domestic livestock grazing program for the Challis planning unit, Rept. 58. 68 pp.

Cowardin, Louis M., V. Carter, F. C. Golet, and E. T. LaRoe. 1977. Classification of wetlands and deepwater habitats of the United States. U.S. Fish & Wildlife Service, Dept. of Interior. 100 pp.

Darling, L., and G. Coltharp. 1973. Effects of livestock grazing on the water quality of mountain streams. Pages 1-8 in Water-animal relations symposium. Proc, U.S. Dep. Agric., Agric. Res. Serv. Kimberly, Id.

Davis, G. 1977. Management alternatives for the riparian habitat in the southwest. Pages 59-67 in Symposium on the importance, preservation, management of riparian habitat. U.S. Dep. Agric. For. Serv. Gen. Rep. RM-43.

Dillon, C. C. 1958. Benefits of rotation deferred grazing on northwest ranges. J. Range Mgt. 11:278-281.

Driscoll, R. S. 1967. Managing public rangelands: effective livestock grazing practices and systems for national forest and national grasslands. USDA Ag. Inf. Bull. 315.

Duff, Don A. 1977. Livestock grazing impacts on aquatic habitat in Big Creek, Utah. In John Mehnke, ed. Symposium on livestock interactions with wildlife, fisheries and their environments. Sparks, Nevada, May 1977. USDA, For. Serv. Pacific Southwest For. and Range Exp. Stn., Berkeley, Calif.

Dunford, E. G. 1949. Relation of grazing to runoff and erosion on bunchgrass ranges. USFS Rocky Mtn. Range Exp. Sta. Res. Note 7, Ft. Collins, Colorado.

Ellison, L. 1960. Influence of grazing on plant succession of rangelands. Botanical Rev. 26(1):1-78.

Extension Publications Office. Effects of season and intensity of use on desert vegetation. Utah State Univ. RB 483.

Forsling, C. L. 1932. A study of the influence of herbaceous plant cover on surface runoff and soil erosion in relation to grazing on the Wasatch Plateau of Utah. USDA Tech. Bull. 220.

Foss, P. O. 1960. Politics and grass: the administration of grazing on the public domain. Univ. of Wash. Press, Seattle, Washington. 263 pp.

Gallizioli, Steve. Livestock vs. wildlife. Presented in a seminar "Improving fish & wildlife benefits in range management" sponsored by the Forty-first North American Wildlife and Natural Resources Conf., Washington, D.C. (In press.)

Gallizioli, Steve. 1977. Statement on improving fish and wildlife benefits in range management. Pages 90-96 in Proceedings of a seminar on improving fish and wildlife benefits in range management (Washington, D.C., March 1976). USDI, Fish and Wildl. Serv., Biological Services Program, Washington, D.C.

Gifford, G. 1975. Beneficial and detrimental effects of range improvement practices on runoff and erosion. Pages 216-248 in Symposium on watershed management. Utah State Univ., Logan.

Gifford, G., and R. Hawkins. 1976. Grazing systems and watershed management: a look at the record. J. Soil Water Conserv. 31(6): 281-283.

Gifford, G. F., J. C. Buckhouse, and F. E. Busby. 1976. Hydrologic impact of burning and grazing on a chained pinyon-juniper site in southeastern Utah. Utah Water Res. Lab., PRJNR012-1.

Gunderson, D. R. 1968. Floodplain use related to stream morphology and fish populations. J. Wildl. Mgt. 32(3):507-514.

Haugen, Gordon W. 1977. Ruby River fishery habitat and range resource evaluation. U.S.D.A. Forest Service, Bozeman, Montana.

Heady, H., et al. 1974. Livestock grazing on federal lands in the 11 western states. J. Range Manage. 27(3):174-181.

Heady, Harold F., and James Bartolome. 1977. The Vale rangeland rehabilitation program: the desert repaired in southeastern Oregon. USDA Forest Service Resource Bulletin, PNW-70. 139 pp.

Heady, Harold F. 1975. Rangeland management. McGraw-Hill Book Co., New York. 460 pp.

Heady, H. F., D. H. Falkenborg, and J. P. Riley, eds. 1976. Watershed management on range and forest lands. Utah Water Res. Lab. proceedings.

Heede, Burchard H. 1976. Gully development and control: the status of our knowledge. Rocky Mtn. Exp. Sta., USFS, Research Paper RM-169.

Heede, Burchard H. 1977. Case study of a watershed rehabilitation project: Alkali Creek, Colorado. Rocky Mtn. Exp. Sta., USFS, Research Paper RM-189.

Hicky, W. C., Jr. 1966. A discussion of grazing management systems and some pertinent literature (abstracts and excerpts) 1895-1966. USDA, USFS, Denver, Colorado.

Hormay, A. L. 1970. Principles of rest-rotation grazing and multiple use land management. U.S. Bureau of Land Management/USFS.

Kennedy, C. 1977. Wildlife conflicts in riparian management: water. Pages 52-58 in Symposium on importance, preservation and management of riparian habitat. U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. RM-43.

Kimball, Jim, and Frank Savage. 1977. Diamond Fork aquatic and range habitat improvements. USDA For. Serv. Int. Reg., Ogden, Utah. 19 pp.

Larin, I. V. 1962. Pasture rotation. Nat. Sci. Foundation, D.C. & Dept. of Ag., Jerusalem. 204 pp.

Leithead, Horace L. 1959. Runoff in relation to range condition in the Big Bend-Davis Mountain section of Texas. J. Range Mgt. 12:83-87.

Leopold, A. Starker. 1974. Ecosystem deterioration under multiple use. Pages 96-98 in Proc. wild trout management symposium. USDI, Fish & Wildl. Serv. and Trout Unlimited, Denver, Colorado.

Liacos, L. G. 1962. Water yield as influenced by degree of grazing in the California winter grasslands. J. Range Mgt. 15:34-42.

Lorz, H. W. 1974. Ecology and management of brown trout in Little Deschutes River. Fishery Research Rpt. No. 8, Oregon Dept. of Fish and Wildlife, Portland, Oregon. 49 pp.

Lusby, G. C. 1970. Hydrologic and biotic effects of grazing vs. non-grazing near Grand Junction, Colorado. J. Range Mgt. 23(4):256-260.

Lusby, G. C., V. H. Reid, and O. D. Knipe. 1971. Effects of grazing on the hydrology and biology of the Badger Wash basin in western Colorado, 1953-66. U.S. Geol. Surv. Water-Supply Pap. 1532-D. 90 pp. + map.

Lusby, G. C., G. T. Turner, J. R. Thompson, and V. H. Reid. 1963. Hydologic and biotic characteristics of grazed and ungrazed watersheds of the Badger Wash basin in western Colorado, 1953-58. USGS Water-Supply Pap. 1532-B. 73 pp.

Marcuson, P. 1970. Rock Creek floodplain investigation. Montana Fish and Game Department. Job Completion Report. F-20-R-13, II.

Marcuson, P. 1970. South central Montana fisheries study. Rock Creek floodplain study. Montana Fish and Game Dept. Project No. F-020-R-14.

Marcuson, P. 1971. Rock Creek floodplain study. Montana Fish and Game Department. Job Progress Report. F-20-R-14, IIa.

Marcuson, P. 1977. The effect of cattle grazing on brown trout in Rock Creek, Montana. Project Number F-20-R-21-11-a. Mont. Dep. of Fish and Game, Helena, Mont. 26 pp.

Martin, S. C., and D. E. Ward. 1970. Rotating access to water to improve semi-desert range near water. J. Range Management 23:22.

McGowan, Terry. 1976. Statement on improving fish and wildlife benefits in range management. Pages 97-102 in Proceedings of a seminar, improving fish and wildlife benefits in range management (Washington, D.C., March 1976). USDI, U.S. Fish & Wildlife Serv., Biological Services Program, Washington, D.C.

Meehan, W., and W. Platts. 1978. Livestock grazing and the aquatic environment: a review. J. Soil Water Conserv. Vol.

Mehnke, John. 1977. Symposium on livestock interaction with wildlife, fisheries and their environments. Sparks, Nevada, May 1977. USDA, For. Serv. Pacific Southwest For. and Range Exp. Stn., Berkeley, Calif.

Neilson, A. B. Effects of overgrazing range lands and seeded pastures and the value of protection in correcting the effects of overgrazing. Thesis - BYU.

Norton, B. E. The management of desert grazing systems. In M. Glantz, ed. The politics of natural disaster. Praeger Publ., N.Y. (In press.)

Oliver, W. H. and D. C. Barnett. 1966. Wildlife studies in the Wells hydroelectric project area. State of Washington - Department of Game. 37 pp.

Packer, Paul E. 1951. An approach to watershed protection criteria. J. For. 46:639-644.

Packer, Paul E. 1961. The effects of grazing on soil erosion water quality and sedimentation. Proc. watershed management study conference, McCall, Ida, USFS & U of I. 24 pp.

Palmer, L. 1976. River management criteria for Oregon and Washington. Geomorphology and engineering. Pages 329-346. Dowden, Hutchinson & Ross, Inc., Stroudsburg, Pennsylvania.

Parsons, D. 1963. Vegetative control of stream bank erosion. In Proc. fed. inter-agency sediment. Conf. (U.S. Dep. Agr. Misc. Publ. 970): 130-136.

Pase, C. P. 1966. Grazing and watershed values of native plants. Pages 31-40 in Native plants and animals as resources in arid lands of southwestern United States. Am. Assoc. Adv. Sci., Rocky Mt. Southwest Div. (Comm. Desert Arid Zones Res., Flagstaff, Ariz., May 1965) Contrib. 8:31-40.

Patterson, D. 1976. Evaluation of habitats resulting from stream bank protection projects in Siskiyou and Mendocino Counties California. Cal-Nev. Wildl. 1976:53-59.

Patton, W. W. An analysis of cattle grazing on steep slopes. Thesis, BYU.

Pfankuch, D. 1975. Stream reach inventory and channel stability evaluation. U.S. Dep. Agric. For. Serv. Northern Reg. Office, Missoula, Montana. 26 pp. (Mimeo)

Platts, William S., and Charles Rountree. 1972. Bear Valley Creek, Idaho aquatic environment and fisheries study. USDA, Forest Service, Intermountain Region, Boise National Forest, Boise, Idaho, 53 pp.

Platts, William S. 1976. Stream channel, streamside environment and thermal conditions of Bear Valley Creek, Idaho. USDA, Forest Service, Intermountain Region, Boise National Forest, Boise, Idaho. 93 pp.

Platts, Wm. S. 1978. Problems in evaluating livestock interactions with fish and their environment. 43rd North American Wildlife and Natural Resources Conference.

Platts, William S., and Wm. R. Meehan. 1977. Livestock grazing and fish environments: situation and needs. Proc. livestock and wildlife-fisheries workshop, Tahoe, Nev.

Platts, W. 1978. Livestock interactions with fish and their environment: a symposium summary. Cal-Nev. 1978. (In press.)

Platts, W., and C. Rountree. 1972. Aquatic environment and fisheries study, Bear Valley Creek, Idaho. U.S. Dep. Agric. For. Serv. Boise, Idaho. 16 pp.

Ratliff, Raymond, et. al. 1972. Rest-rotation grazing at Harvey Valley. USDA Forest Service Res. Paper PSW-77.

Rauzi, F. 1973. Infiltration rates: three soils with three grazing levels in northeastern Colorado. J. Range Man. 26:126-9.

Rauzi, F., and C. O. Hanson. 1966. Water intake and runoff as affected by intensity of grazing. J. Range man. 19:351-6.

Renner, F. G. 1936. Conditions influencing erosion on the Boise River watershed. U.S. Dep. Agric. Tech. Bull. 528. 32 pp.

Saltzman, William O. 1976. Impact of stream-side use on fisheries. Pages 160-163 in Columbia River salmon and steelhead, special publication No. 10. Amer. Fish. Soc., Washington, D.C.

Sartz, Richard S., and David N. Tolstead. 1974. Effect of grazing on runoff from two small watersheds in southwestern Wisconsin. Water Resour. Res. 10:354-356.

Sharp, A. L., J. J. Bond, J. W. Newberger, A. R. Kuhlman, and J. K. Lewis. 1964. Runoff as affected by intensity of grazing on rangeland. J. Soil & Water Conserv. 19:103-106.

Skovlan, Jon M., William R. Meehan, John C. Buckhouse, and Martin Vavra. 1977. Paper presented at Livestock and Wildlife-Fisheries Workshop, Reno, Nevada, May 3-5, 1977.

Stoddart, Laurence A., Arthur D. Smith, and Thadis W. Box. 1975. Range management. 3rd Ed. McGraw-Hill Book Co., New York. 532 pp.

Thomas, J. W. 1970. A comparison of vegetation changes in a mountains brush type after grazing and protection from grazing during 37 years. Thesis BYU.

Thomas, Jack Ward, Chris Maser, and Jon E. Rodick. 1977. Riparian zones--their importance to wildlife and their management. Reno Wildlife Workshop, April 1977.

Tower, J. D. 1970. Response of range forage to varying degrees of protection from grazing. M.S. Thesis, U. of Nevada.

Townsend, Joseph E., and Robert J. Smith. 1977. Proceedings of a seminar, improving fish and wildlife benefits in range management. (Washington, D.C., March 1976). USDI, Fish & Wildl. Serv., Biological Services Program, Washington, D.C. 118 pp.

Turner, G. T. 1971. Soil and grazing influences on a salt-desert shrub range in Western Colorado. J. Range Man. 24(1):31-7.

U.S. Fish & Wildl. Serv. 1977. Improving fish and wildlife benefits in range management. U.S. Fish Wildl. Serv. FWS/OBS-77-1, Washington, D.C

U.S. Forest Service. Symposium on the importance, preservation, and management of riparian habitat. General Tech. Report RM-43 Research Support Services, Fort Collins, Colo.

U.S. Forest Service. 1974. Range management policy statement. Pacific Northwest Region, Portland, Oregon. 8 pp.

U.S. Forest Service. 1977. Livestock interactions with fish and their environments. Pacific Southwest Forest and Range Exp. Stn., Berkeley, California. In preparation.

Vallentine, 1971. Range development and improvements. BYU Press.

Van Velson, Rod. 1977. The rainbow trout in the North Platte Valley. Nebraska Game and Parks Commission.

Wagner, Frederic H. 1977. Effects of livestock grazing and the livestock industry on wildlife. In John Mehnke, ed. Symposium on livestock interactions with wildlife, fisheries and their environments. Sparks, Nevada, May 1977. USDA, Pacific Southwest For. and Range Exp. Stn., Berkeley, Calif.

White, Ray J., and Oscar M. Brynildson. 1967. Guidelines for management of trout stream habitat in Wisconsin. Technical Bulletin Number 39. Department of Natural Resources, Division of Conservation, Madison, Wisconsin. 65 pp.

Winegar, Harold H. 1977. Camp Creek channel fencing-plant, wildlife, soil and water responses. Rangeman's Journal 4(1):10-12, Feb. 1977.